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(71) Applicant: **Sika Corporation**
Madison Heights, MI 48071 (US)

(72) Inventors:
- **Hopton, Gregory W,**
  Novi, Mi48374 (US)
- **Blank, Norman E., Sika Ag**
  8048 Zürich (CH)
- **Fitzgerald, Gerald**
  Clinton Township, Michigan 48038 (US)
- **Stratman, Randy**
  Waterford, Mi 48372 (US)
- **Chang, Chin- Jui,**
  Troy, Mi 48098 (US)

(74) Representative: **Blum, Rudolf Emil Ernst et al**
c/o E. Blum & Co
Patentanwälte
Vorderberg 11
8044 Zürich (CH)

(54) Reinforcing member with beam shaped carrier and thermally expansible reinforcing material

(57) A reinforcing member (34a) for reinforcing a hollow structural member of an automobile, aircraft, boat, etc. includes a carrier (38) which has first and second spaced apart walls (60,62), wherein the spaced apart walls (60,62) are connected by a connecting wall (58). Reinforcing elements (40,42) comprising thermally expansible material (39) are positioned in overlaying relationship to the first and second spaced apart walls (60,62). Said expansible material (39) is attached by fastening means (44,72) to said carrier (38) which preferably has an expansion temperature similar to the temperatures achieved in a specific stage of a particular manufacturing process.

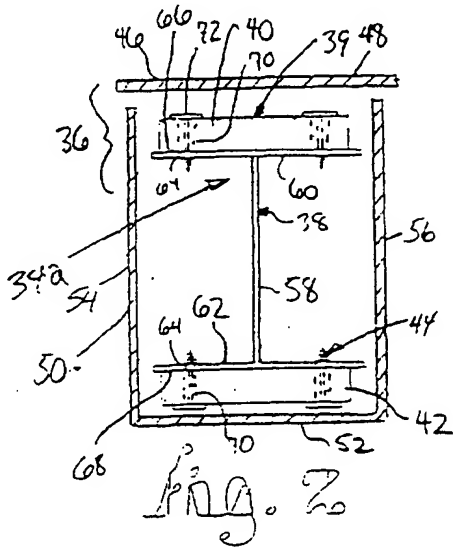

Fig. 2a

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[0007] These and other advantages will be readily appreciated by those skilled in the art with reference to the drawings and the following description, which are intended to be exemplary rather than limiting.

Brief Description of the Drawings

[0008]

Fig. 1 is a front perspective view of an automobile body, illustrating various locations into which a reinforcing member of the present invention may be utilized;

Fig. 2 is a front elevation view of a reinforcing member of the present invention having thermally expansible structural reinforcing material elements coupled by fasteners to a beam shaped carrier and located within a channel-shaped structural member having a plate enclosing the channel onto which the plate is placed;

Fig. 3 is a perspective view of the reinforcing member of Fig. 1, with portions of one of the side walls of the channel broken away and foreshortened for clarity;

Fig. 4 is a front elevational view of a reinforcing member showing a second embodiment of the present invention wherein the thermally expansible structural reinforcing material elements are coupled to the carrier by strips of structural tape;

Fig. 5 is a perspective view of the reinforcing member of Fig. 4 positioned in a channel-shaped structural member, with portions of the structural member foreshortened and one side wall broken away for clarity;

Fig. 6 is a front elevational view of a reinforcing member in accordance with a third embodiment of the present invention, the carrier including a box beam central portion and having thermally expansible structural reinforcing material elements attached thereto by structural tape, the reinforcing member being located within a channel shaped structural member with a plate enclosing the channel;

Fig. 7 is a perspective view of the reinforcing member shown in Fig. 6;

Fig. 8 is a front elevational view of a reinforcing member in accordance with a fourth embodiment of the present invention wherein the carrier includes upright walls for providing a friction fit to locating and fasten the thermally expansible reinforcing material element thereon, the reinforcing member shown positioned within a channel-shaped structural member;

Fig. 9 is a perspective view of the reinforcing member shown in Fig. 8;

Fig. 10 is a front elevational view of a fifth embodiment of the present invention, showing the carrier having two upright walls for positioning the reinforcing material elements adjacent the side walls of the structural member into which it is received;

Fig. 11 is a perspective view of the reinforcing member shown in Fig. 10, with portions of the channel member foreshortened and broken away for clarity and showing the use of structural tape to fasten the reinforcing material elements to the carrier;

Fig. 12 is a front elevational view of a reinforcing member in accordance with a sixth embodiment of the present invention, wherein the beam carrier presents opposed legs inwardly extending from the carrier end walls with the reinforcing material elements attached by mechanical fasteners to the legs, the reinforcing member being shown within a channel shaped structural member;

Fig. 13 is a perspective view of the reinforcing member shown in Fig. 12;

Fig. 14 is front elevational view of a seventh embodiment of the present invention, wherein the beam-shaped carrier includes opposed legs and the reinforcing material elements are adhesively attached to the carrier, the reinforcing member being shown received within a channel-shaped structural member;

Fig. 15 is a perspective view thereof, with portions of the structural member broken away and foreshortened for clarity;

Fig. 16 is a front elevational view of a reinforcing member in accordance with an eighth embodiment of the present invention, wherein the thermally expansible structural reinforcing material elements are configured to include a slot to provide a mechanical attachment to the carrier, and shown within a channel-shaped structural member;

Fig. 17 is a perspective view of the embodiment depicted in Fig. 16, with portions of the structural member broken away;

Fig. 18 is a perspective view showing a ninth embodiment of the reinforcing member of the present invention positioned within a channel-shaped structural member wherein the carrier includes at least one arcuate bend along its longitudinal length;

Fig. 19 is a vertical elevational view of the reinforcing member of Fig. 18 with one side wall of the channel-shaped structural member removed for clarity to show its positioning within the channel prior to foaming and expansion of the reinforcing material;

Fig. 20 is an enlarged vertical cross-sectional view showing the reinforcing member of Fig. 18 with the structural reinforcing material elements attached to the carrier by push pins;

Fig. 21 is an enlarged vertical cross-sectional view of a tenth embodiment of the reinforcing member of the present invention which is similar to that shown in Fig. 20, but wherein the reinforcing material elements are attached to the carrier by bendable tabs formed along the margins of carrier;

Fig. 22 is a vertical cross-sectional view of an elev-

oughly mixed to obtain a substantially homogeneous mixture. The desired amount of this mixture is placed in a heated mixer (set at a temperature of about 250°F) and mixing is commenced. While mixing, the carbon black and rubber are added to the mixer and mixing is stopped once a homogeneous mixture is obtained within the mixer. Either the silica or glass microspheres is added to the mixer, and mixing is resumed and continued until the mixture is homogeneous. This step is repeated, adding the other of the silica or glass microspheres.

[0014] The temperature of the mixer is then set to a temperature below 160°F, the blowing agent(s), catalyst (s), kicker, and curing agent(s) are added, and mixing is resumed and continued only until the mixture is homogeneous. The resulting mixture is then preferably extruded into strands (at an extruder temperature of 170-180°F and screw rotation speeds of about 400 rpm) and cut into pellets. The pellets are then injection molded at a temperature of about 180-200°F using injection molding equipment designed to form the desired shape of the expandable member 12 to be attached to the carrier 38.

[0015] The carrier 38 is presented in the form of an I-beam which includes an upright web 58 and two parallel end walls 60 and 62 at the ends of the web. The end walls 60 and 62 each include a plurality of holes 64 therethrough. The carrier 36 presents a longitudinal axis which is aligned with and preferably extends along the longitudinal axis of the channel 50. The foamable material elements 40 and 42 are attached on the outwardly oriented surfaces 66 and 68 of end walls 60 and 62, respectively, thereby being oriented for engaging the cap 46 and base wall 52, respectively upon foaming. The foamable material elements 40 and 42 each include openings 70 aligned with the holes 64 through the carrier 38, to thereby receive mounting component 44. Mounting component 44 as used in the first embodiment shown in Figs. 1 and 2 is a mechanical fastener such as a push pin 72, which may be of synthetic resin and have a shank extending through the foamable material elements 40 and 42 and through the carrier 38 so as to hold the elements 40 and 42 on the carrier 38 prior to foaming. The push pin 72, for example of nylon and having a higher melting temperature than the foamable material 39, may have ridges along the shank to grip the foamable material elements 40 and 42, and the holes 64 and openings 70 may be slightly larger than the shank to permit some limited flexibility to allow the foamable material elements 40 and 42 to absorb impact.

[0016] In use, the reinforcing member 34a is placed into the channel 50 whereby the foamable material element 40 contacts the base wall 52 and the foamable material element 42 is in close proximity to the plate 46. Upon activation of the foamable material 39 by, for example, heating, the plate 46 is structurally bonded to the channel 50 with the reinforcing member adding rigidity thereto.

[0017] Figs. 4 and 5 illustrate a second embodiment 34b of the reinforcing member. The carrier 3 8b and reinforcing material elements 40b and 42b are configured and positioned similarly to that shown in Figs. 2 and 3, with the exception that no holes or openings are required. Foamable material elements 40b and 42b are instead fastened to the carrier 38b by mounting component 44b provided as structural tape 74. The structural tape 74 is known to those skilled in the art, and may be embedded in the elements 40 or 42 or provided with adhesive on both sides 76 and 78 thereof, and is provided as thin strips in order to maximize bonding of the thermally expansible reinforcing material to the carrier after activation..

[0018] Figs. 6 and 7 illustrate a third embodiment 34c of the reinforcing member. The carrier 80 thereof includes a central rectangular box beam 82, an upper web 84 and a lower web 86, each with a respective parallel end walls 60 and 62, again without holes therein. The box beam 82 presents a top panel 88, bottom panel 90, and side panels 92 and 94. The side panels 92 and 94 enable additional structural reinforcing elements 96 and 98 of thermally expansible structural reinforcing material 39 to be attached thereto using the structural tape 74, and thus permits additional bonding of the carrier to the side walls 54 and 56, respectively of the channel 50 and adds both horizontal and vertical reinforcement to the surrounding structural member to provide a reinforced structural member after foaming, expansion and bonding of the reinforcing material elements..

[0019] Figs. 8 and 9 illustrate a fourth embodiment 34d of the reinforcing member. The carrier 100 presents opposed, parallel side panels 102 and 104, each having an upper edge 106 and a lower edge 108. Three substantially parallel horizontal webs 110, 112, and 114 are positioned between the side panels 102 and 104 and positioned interiorly of the edges 106 and 108. The positioning of the uppermost web 110 and the lowermost web 114 present flanges 116 which serve as the mounting component 44 to fasten the elements to the carrier. Central web 112 also lies in a horizontal plane as viewed in Figs. 8 and 9, but it may be appreciated that the carrier 100 may be oriented 90 ° to that shown. The thermally expansible structural reinforcing material 39 is provided as side reinforcing material elements 118 and 120 coupled by adhesive 121 to the outer faces of the side panels 104 and 106, and upper reinforcing material element 122 and lower reinforcing material element 124 are mounted by their nibs 126 which frictionally engage the flanges 116 to hold the upper and lower reinforcing material elements in place. After foaming, expansion and bonding of the elements, the carrier 100 is bonded to both the plate and the channel to provide a reinforced structural member.

[0020] Figs. 10 and 11 show a fifth embodiment 34e of the reinforcing member hereof, which is similar to the embodiment 34b shown in Figs. 4 and 5. The H-beam carrier 38e is oriented at 90° to that shown in Figs. 2

include enlarged areas for receiving the heads of the push pins so that the foamable material in elements 206 and 208 may lie flush against the surrounding structure of the channel of a cross-member 224 or other frame component. The push pins 72 are preferably synthetic resin such as nylon which has a lower heat conductivity than metal, thereby providing both a blockage to convection through the openings and holes and avoiding localized high conductivity which might inhibit even expansion of the foamable material. In addition, the synthetic resin push pin helps to absorb shock resulting from impact to the foamable material during handling and installation. As may be seen in Figs. 19 and 20, the frame member may be a generally u-shaped cross member 224 which receives the reinforcing member 34i in the channel defined therein over a humped section 226 generally midway along its length. It is to be understood that the frame member is provided with a covering plate which conforms to the upper edge of the cross-member 224, whereby upon foaming, expansion and bonding, the material 39 bonds the carrier to the cross-member and covering plate to provide a reinforced structural member.

[0025] Fig. 21 illustrates a tenth embodiment of the reinforcing member 34j of the present invention which is similar in configuration and use to that shown in Figs. 18, 19 and 20. However, instead of fastening the reinforcing material elements 206 and 208 to the carrier by push pins, the carrier 228 formed of back-to-back C-shaped channels 230 and 232 have outwardly extending upper and lower arms 234 which include, at longitudinally spaced intervals along the remote margins of flanges 198 and 200, bendable tabs 236 which include a finger 238 extending over the outer surface of the elements 206 and 208 and a stretch 240 approximately the width of the element 206. Because of the provision of the terminal bends 220 and 222, the tabs 236a on flanges 202 and 204 include only fingers 238. The tabs 236 and 236a thereby secure the reinforcing material elements 204 and 206 to the carrier 228 prior to activation of the thermally expansible reinforcing material 39. After foaming, expansion, and bonding of the material 39, the carrier is bonded to the structural member as described above to provide a reinforced structural member.

[0026] Fig. 22 illustrates an eleventh embodiment of the reinforcing member 34k of the present invention, showing the use of a C-shaped beam carrier 242 which is secured to the plate 46 by rivets 244. The beam carrier 242 is provided with two elongated longitudinally extending walls which. when viewed in section appear as arms 246 and 248 and a connecting wall 250, with inwardly turned flanges 252 of the C-shaped beam carrier 242 presenting an open mouth 254 oriented downwardly whereby the arms 246 and 248 are oriented toward the respective side walls 54 and 56 of the channel 50 and the connecting wall is oriented toward the plate 46. Thermally expansible structural reinforcing material 39 is provided as structural reinforcement material element 256 which extends around the outer facing surfaces of the arms 246 and 248 and connecting wall 250 and is secured in place by push pins 72. After foaming, expansion and bonding, the carrier 242 is bonded to the channel 50 and the plate 46 to provide a reinforced structural member.

[0027] Fig. 23 illustrates a twelfth embodiment of the reinforcing member 341, where the C-shaped beam carrier 242 is oriented substantially 90 ° to that shown in Fig. 22 and the arm 248 is secured to the plate 46 by rivets 244. The reinforcing member 341 uses the structural reinforcement material element 256 as described above, but adds a second structural material reinforcement material element 258 received through the open mouth 254 of the carrier and positioned between arms 246 and 248. The elements 256 and 258 are held in position prior to activation by push pins 72 which extend into a hole 260 in element 258 and grip against the sides of the hole. The use of two elements 256 and 258 permits the use of different reinforcing materials 39, if desired, and/or facilitates the bonding of the reinforcing member 341 to both side walls and the base wall of the channel, as well as the plate 46 when additional material 39 is used to enhance structural rigidity.

[0028] Fig. 24 illustrates a thirteenth embodiment of the reinforcing member 34m of the present invention, where a C-shaped beam carrier 262 is provided which is coupled to the plate 46 by, for example, threaded fasteners 264. The carrier 262 includes arms 266 and 268 joined by connecting wall 270. Thermally expansible structural reinforcing material 39 is provided as E-shaped reinforcing material element 272. The element includes a central block portion 274 received through the open mouth 276 of the carrier 262 into the interior thereof between the arms 266 and 268, and further includes legs 278 and 280 which extend over the exterior surfaces of the arms 266 and 268 and thus leg 278 is positioned between the carrier and the plate 46 and the leg 280 is positioned between the carrier and the base wall 52. Each leg 278 and 280 includes a shoulder 282 which extends past the arms to engage the connecting wall 270 and thereby aid in holding the element 272 in position. A push pin 72 may provide further attachment of the element 272 to the carrier prior to foaming, expansion and bonding, whereupon the carrier is bonded to the channel and the plate 46 to provide a reinforced structural member.

[0029] Fig. 25 illustrates a fourteenth embodiment of the reinforcing member 34n of the present invention wherein a block-beam shaped carrier 284 is provided. The block may be metal or, more advantageously, nylon or other synthetic resin material having a higher melting point than the bake temperature to which the reinforcing member 34j is subjected to activate the material 39. The carrier is provided with reinforcing material 39 as a reinforcing material element 256 as described above. The carrier 284 may be secured to the plate by push pins or

9. The reinforcing member of claim 8, wherein said carrier (80) includes a rectangular box beam (82) positioned intermediate the spaced apart end walls (60,62).

10. The reinforcing member of claim 9, including a second reinforcing material element (96,98) and fastening means for attaching said second reinforcing material element (96,98) to said box beam (82).

11. The reinforcing member of one of claims 8-10, wherein said carrier (132) includes at least two flanges (138,140,142,144) extending at an oblique angle from the margins of said end walls (134, 136), second and third reinforcing material elements (150,152,154,156) positioned on said flanges (138,140,142,144) and fastening means (72) for fastening said second and third reinforcing material elements (150,152,154,156) to said flanges (138,140,142,144).

12. The reinforcing member of one of claims 8-11, wherein said carrier (132) includes at least two flanges (138,140,142,144) extending at an oblique angle from the margins of said end walls (134,136), and wherein said reinforcing material element (158,160) is fastened to said carrier (132) by said fastening means (170) to said surface and at least one flange (138,140,142,144) of one end wall (134, 136).

13. The reinforcing member of one of the preceding claims, wherein said carrier (192) is elongated and has a lower leg portion (210,212) and a raised segment (218) along the longitudinal length, and wherein said reinforcing material element (206,208) generally conforms to said surfaces of said carrier (192).

14. The reinforcing member of one of the preceding claims, wherein said carrier (192,228,242,262) is substantially C-shaped presenting a pair of arm walls (198,200,202,204,234,246,248,266,268) defining said surfaces, said arm walls (198,200, 202,204,234,246,248,266, 268) extending from said connecting wall (196,250,270) in opposed relationship, and wherein said fastening means (72,244,264) attaches said reinforcing material element (206,208,256,272) in covering relationship to said arm walls (198,200,202,204,246,248, 266,268).

15. The reinforcing member of claim 14, including a second reinforcing material element (258) positioned intermediate said arm walls (246,248).

16. The reinforcing member of claim 15, wherein said second reinforcing material element (258) is positioned in engagement with said arm walls (246,248).

17. The reinforcing member of one of the preceding claims, wherein said carrier (262) is substantially C-shaped presenting a pair of arm walls (266,268) defining said surfaces, said arm walls (266,268) extending from said connecting wall (270) in opposed relationship, and wherein said reinforcing material element (272) is substantially E-shaped including a pair of legs (278, 280) positioned in overlying relationship to said arm walls (266,268).

18. The reinforcing member of one of the preceding claims, wherein said expansible material (39) comprises an SBS block co-polymer, a polystyrene, a rubber, a bisphenol A-based liquid epoxy resin, carbon black, silica, glass microspheres, a blowing agent, a catalyst, and a curing agent.

19. The reinforcing member of one of claims 1-7 and 11-12 and 18, wherein said carrier (284) is a substantially solid block.

20. In combination; a structural member presenting a base wall (52) and at least one side wall (54, 56) defining a channel (50) therein, and a plate (46) for enclosing said channel (50); and a reinforcing member (34), according to one of the preceding claims positioned in said channel (50), wherein upon foaming and expansion of said reinforcing material element (40,40b,42,42b,96, 98, 118, 120, 122, 124, 128, 130, 146, 148, 158, 160, 172, 174, 204, 206,208,256,258,272), said carrier (38,38b,38e, 80,100,132, 192,228,242,262,284) is bonded to said structural member.

21. The combination of claim 20, wherein said carrier (132) includes at least two flanges (138, 140,142,144) extending at an oblique angle from the margins of said end walls (134,136), and wherein said reinforcing material element (150,152, 154,156) is fastened to said carrier (132) by said fastening means (72) to said surface and at least one flange (138,140,142,144) of one end wall (134,136) between said carrier (132) and said structural member.

22. The combination of one of claims 20-21, wherein said carrier (242,262) is substantially C-shaped presenting a pair of arm walls (246,248,266,268) defining said surfaces, said arm walls (246,248, 266,268) extending from said connecting wall (250,270) in opposed relationship, and wherein said fastening means (72,244,264) attaches said reinforcing material element (256,272) in covering relationship to said arm walls (246,248,266,268) with said element (256,272) positioned intermedi-

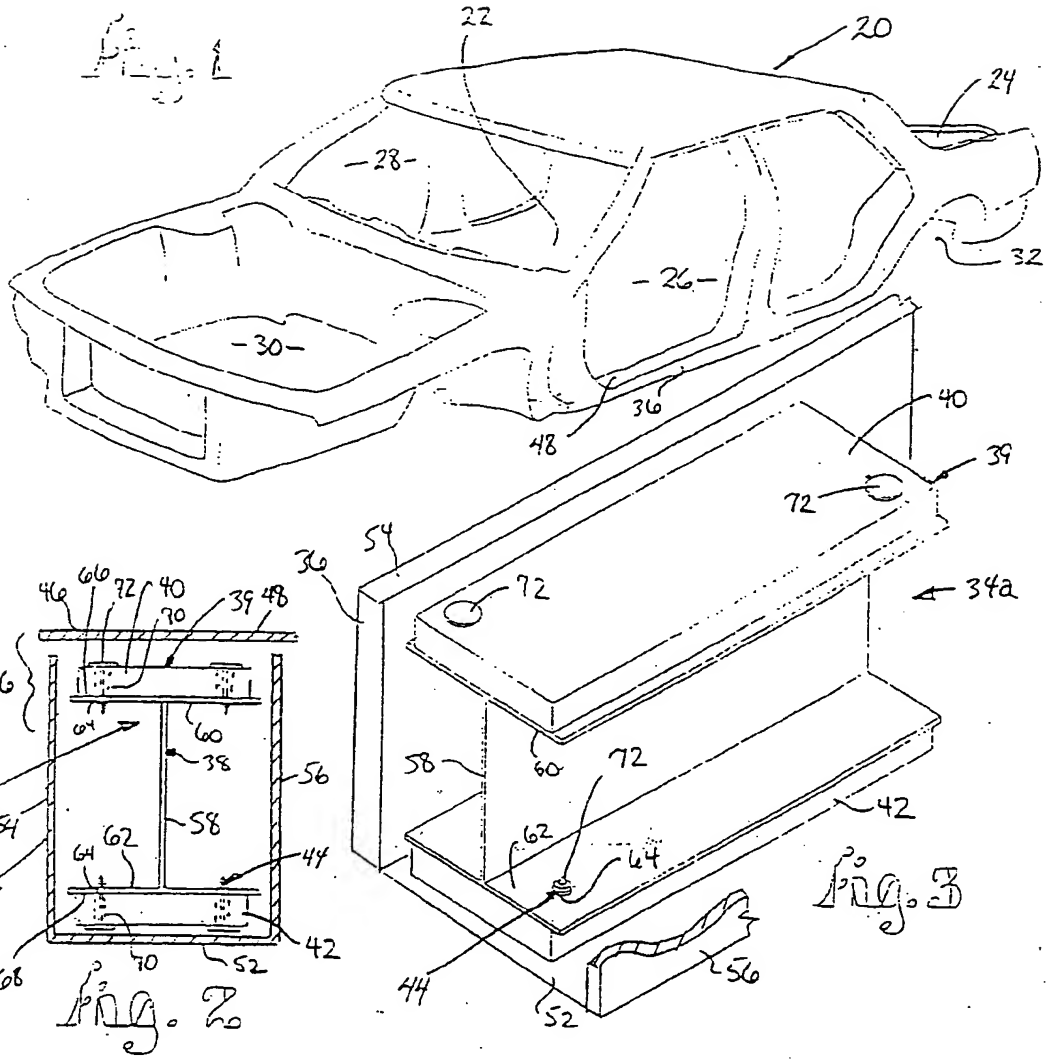

Fig. 1

Fig. 2

Fig. 3

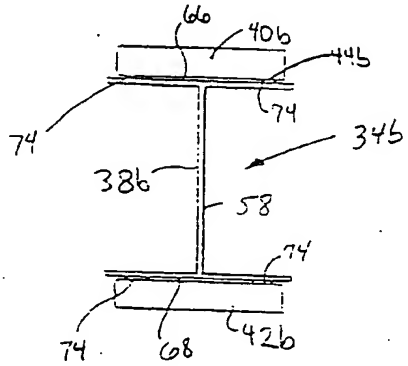

Fig. 4

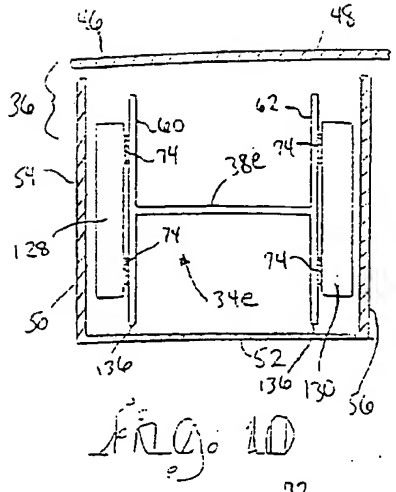

Fig. 10

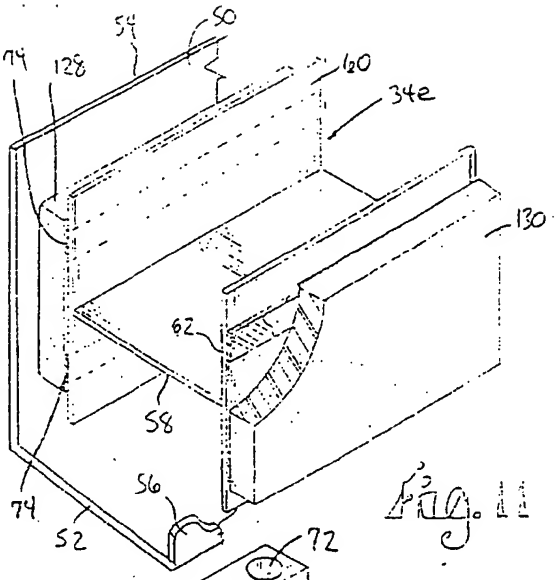

Fig. 11

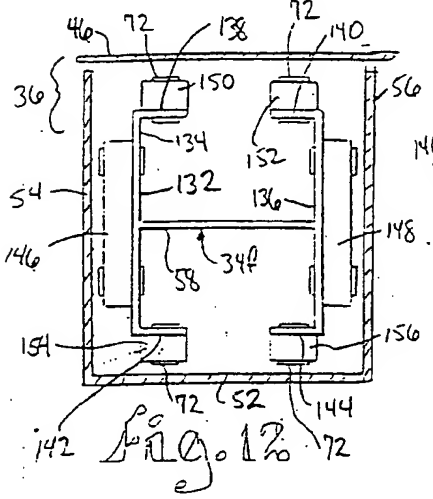

Fig. 12

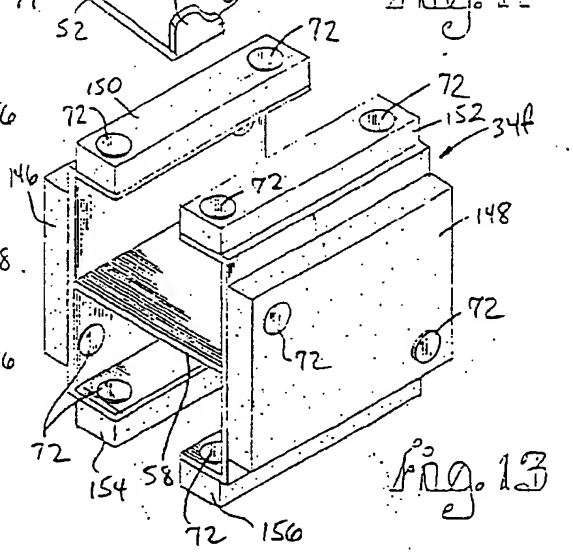

Fig. 13

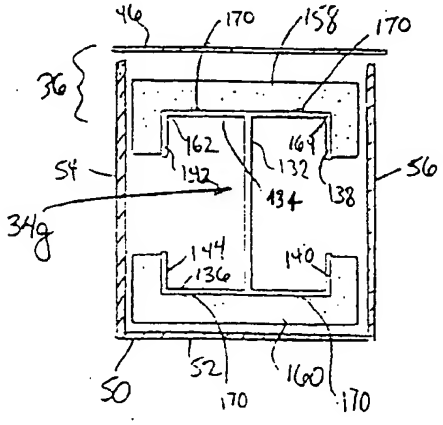

Fig. 14

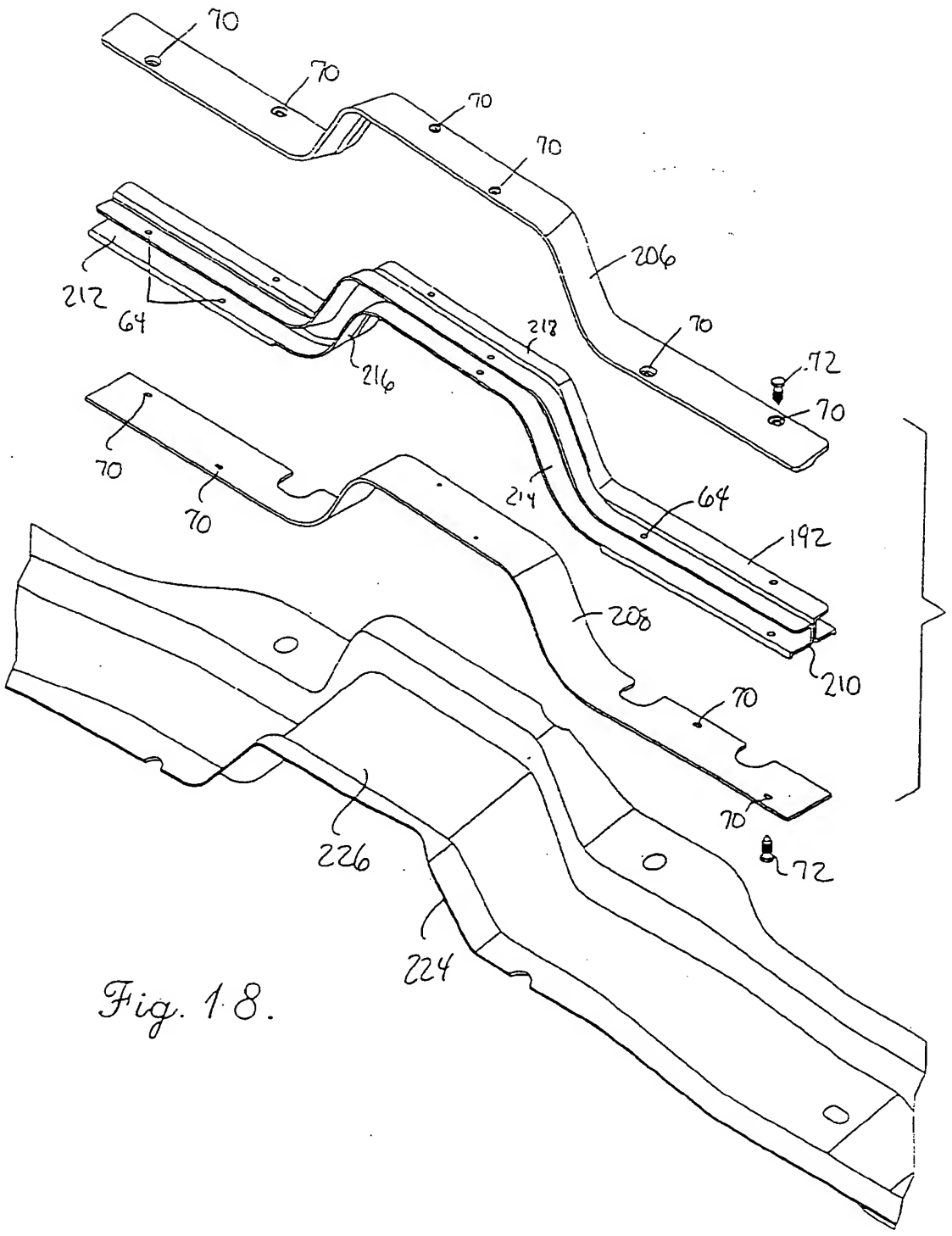

Fig. 1.8.

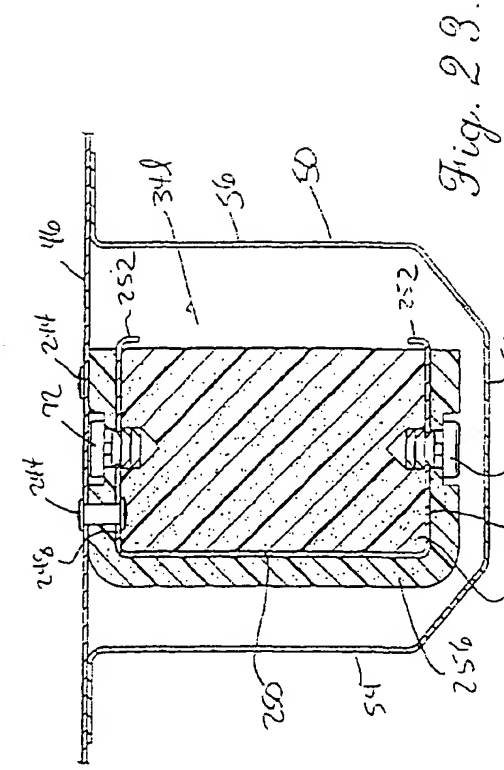

Fig. 23.

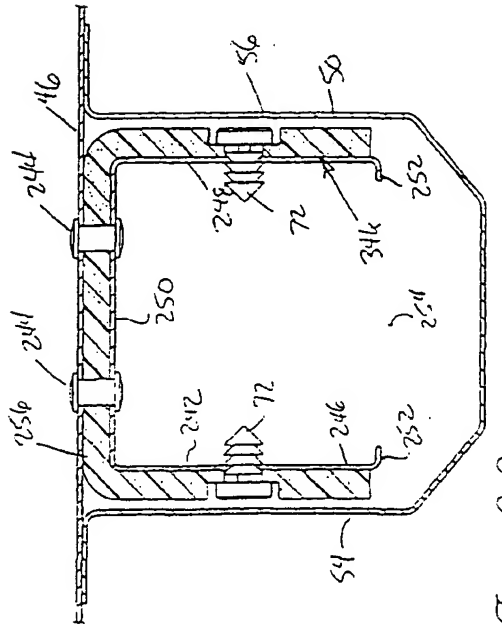

Fig. 22.

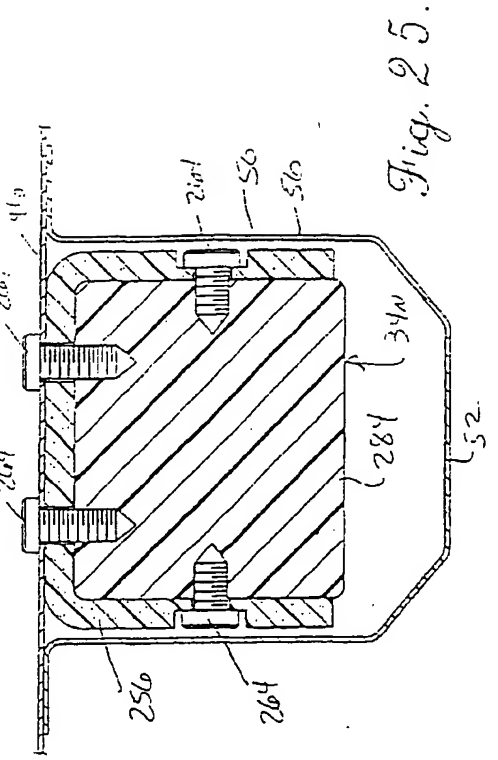

Fig. 25.

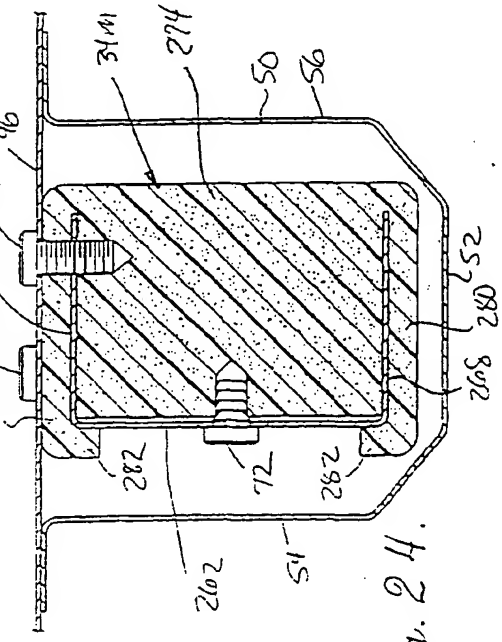

Fig. 24.